

Microturbine Applications and Issues

***Presented to the Mid-Atlantic
Distributed Energy Resources
Workshop***

***Presented by Kevin Duggan
Capstone Turbine Corporation
February 21, 2002***



Lessons from the field

To deliver full benefit, DER must:

- Deliver economic value, either by meeting a unique customer need (niche) or by providing a payback within 2 – 3 years.
- Be safe and reliable.
- Be clean. The technology is located near people and must be clean if it is to be accepted.
- Resolve the regulatory issues.



Remote power application, Anchorage, AK

Broad Range of Market Applications

Cooling Heating and Power



Power Quality/Reliability/Cost-Savings



- Diverse range of applications
- Commercial fuel flexibility:
 - Natural Gas, CNG, LNG
 - Renewable landfill & digester gases
 - Propane, LPG
 - Diesel, kerosene, JP8
 - Coalbed methane
 - Flare gases (sweet and sour)
- Rapid adoption comparable with other new energy technologies

Renewable/Waste Gases



Hybrid Electric Vehicles



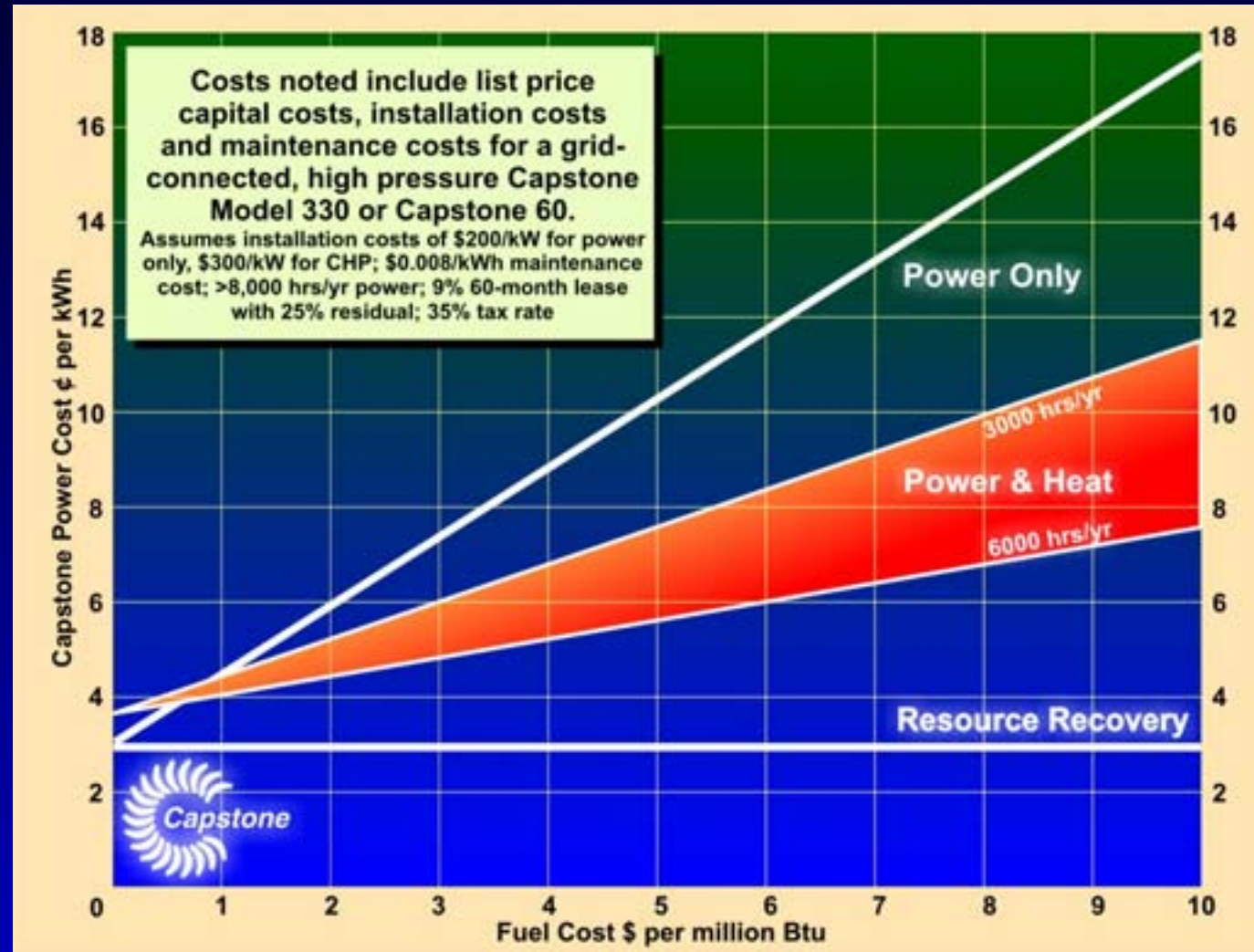
Microturbines are cost competitive in many broad based applications



MicroTurbines may generate energy at a lower cost than peak utility power. Thus businesses pay less for electricity AND leave more power available for all others in the region.



Capstone 60
at an HVAC
manufacturer
in California



Building CHP in Upstate New York



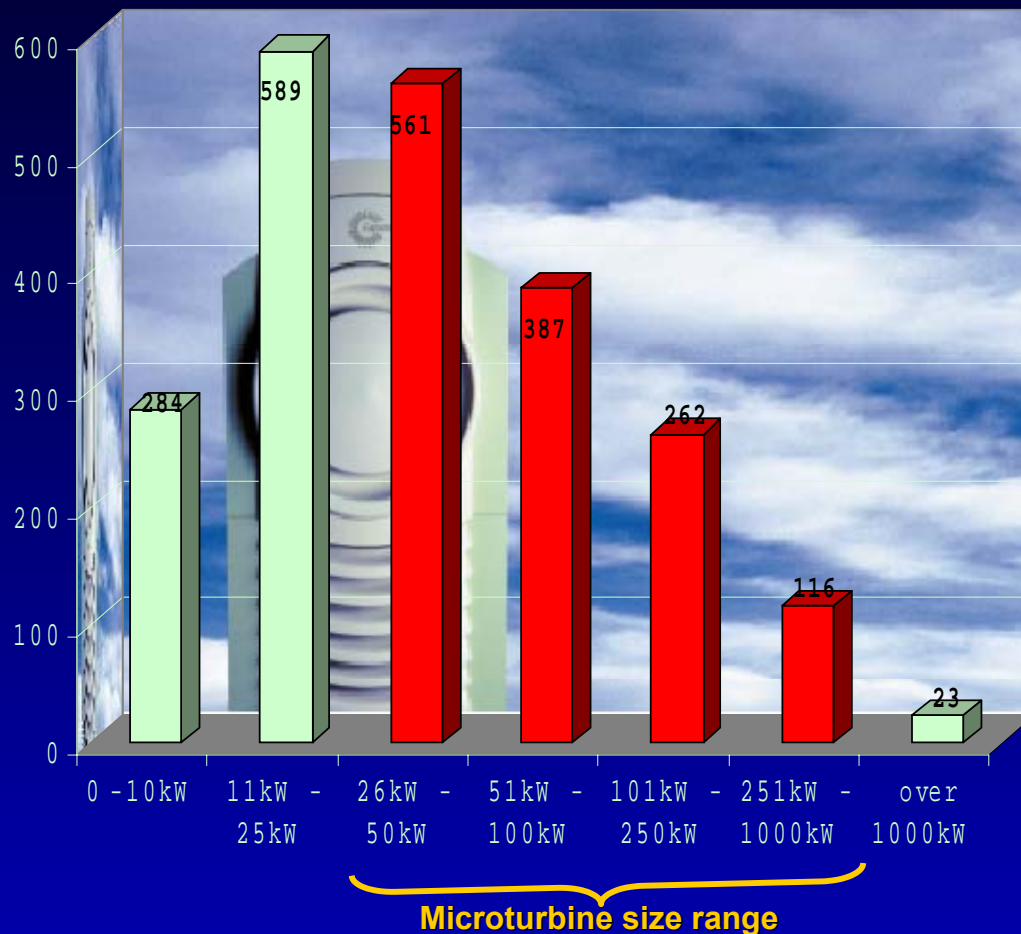
Harbec Plastics CHPC (Ontario, NY)
25 Capstone 30 kW microturbines, 4 Unifin Heat Exchangers,
200 Ton Carrier Absorption Chiller

- **>70% fuel efficient electricity, heat and zero-load cooling**
- **Significant energy cost reduction (power *and* gas) from utility rates**
- **Removes cooling load during peak demand times**
- **>90% fewer NOx emissions per kWh than natural gas central power plants⁽¹⁾**
- **Reduces greenhouse gases**
- **US aggregate potential market for micro-CHP <2 MW = 82 GWs**

(1) Per EPA utility emissions data and CERA's independent measurement of Capstone emissions

Most Building CHP applications are in the Microturbine Size Range

Number of Buildings ('000) classified by peak load requirements



60 percent of buildings in the US have peak loads that are within the microturbine size range.

Power Quality/Reliability



One of 5 units installed at Capstone's production facilities. Enabled Capstone to expand production while avoiding added load to the utility and the need for new distribution capacity.

- Supply high-reliability power to critical and sensitive loads
- Remove demand on utility grid, reducing utility need to build additional peaking capacity
- Built-in redundancy provides high nines reliability
- Eliminate outage costs
- 30/60 kW per module size provides low cost n+x redundancy
- Ultra-low emissions makes viable UPS with ongoing generation
- Reduces battery array reliance/footprint

Renewable Installations



Inland Empire, CA
Wastewater Treatment
Plant RP-1



Los Angeles Lopez Canyon Landfill – 50 Capstone
MicroTurbines produce enough electricity from landfill
flare gases to power to 1,500 homes

- Turns low-energy (as low as 350btu/scf) waste into sustainable profit.
- Reduces load on the grid
- CHP applications support digester temperature at WWTPs
- Avoid environmental penalties
- Burn sour and/or low-Btu gases that cannot be utilized by other technologies.
- NO_x emissions independently measured as low as 1.3 ppm

Oil & Gas Resource Recovery



Offshore Housing on Chevron Platform in Gulf of Mexico



Two-Pack Housing in a Remote Alberta Oilfield

- Reduces costs of operating remote oil fields
- Avoid environmental penalties
- Burn sour gases that cannot be utilized with other technologies
- NO_x emissions as low as 1 ppm
- Avoid electrification costs or
- Export into local power pool
- Estimated resource recovery market for United States and Canada is 1,126 MW ⁽¹⁾

(1) Management estimates and CERA "The Next Generation: Fuel Cells and Microturbines" 1998

Capstone-Energized Hybrid Electric Vehicles



3 vehicles entered revenue service in Christchurch, NZ in March, 2000

After 18 months, 96% availability was demonstrated for revenue service:

Bus #1: 65,456 miles (105,342 km)

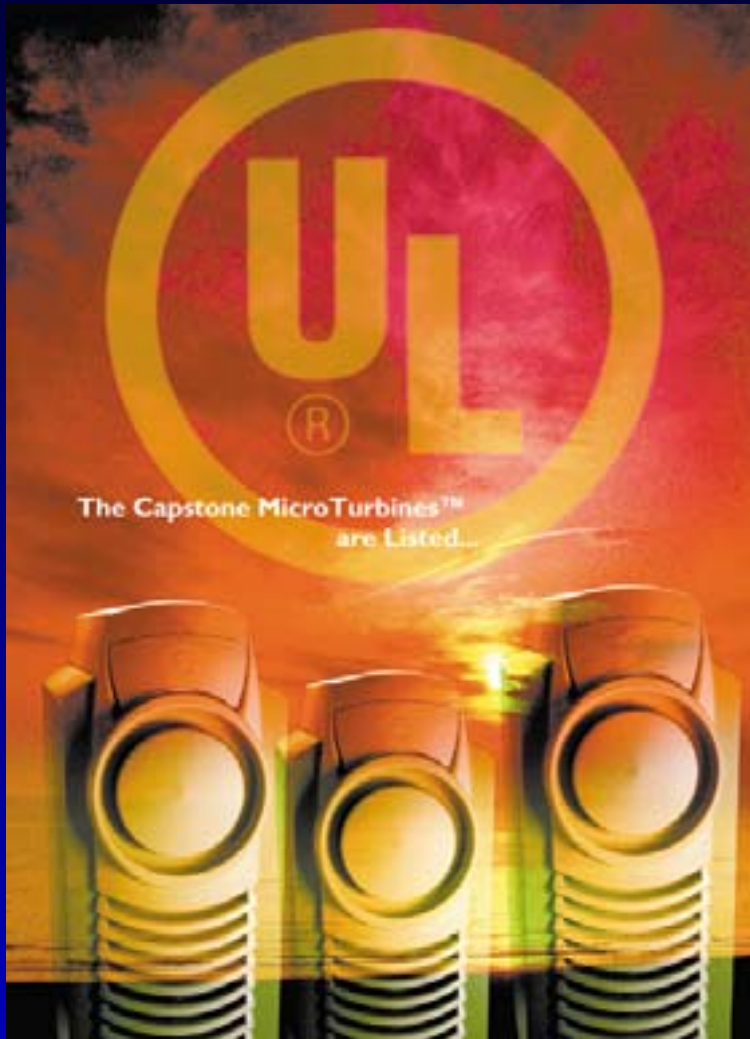
Bus #2: 70,474 miles (113,418 km)

Bus #3: 53,449 miles (86,018 km)

... with no microturbine engine maintenance
other than air filters and one spark plug

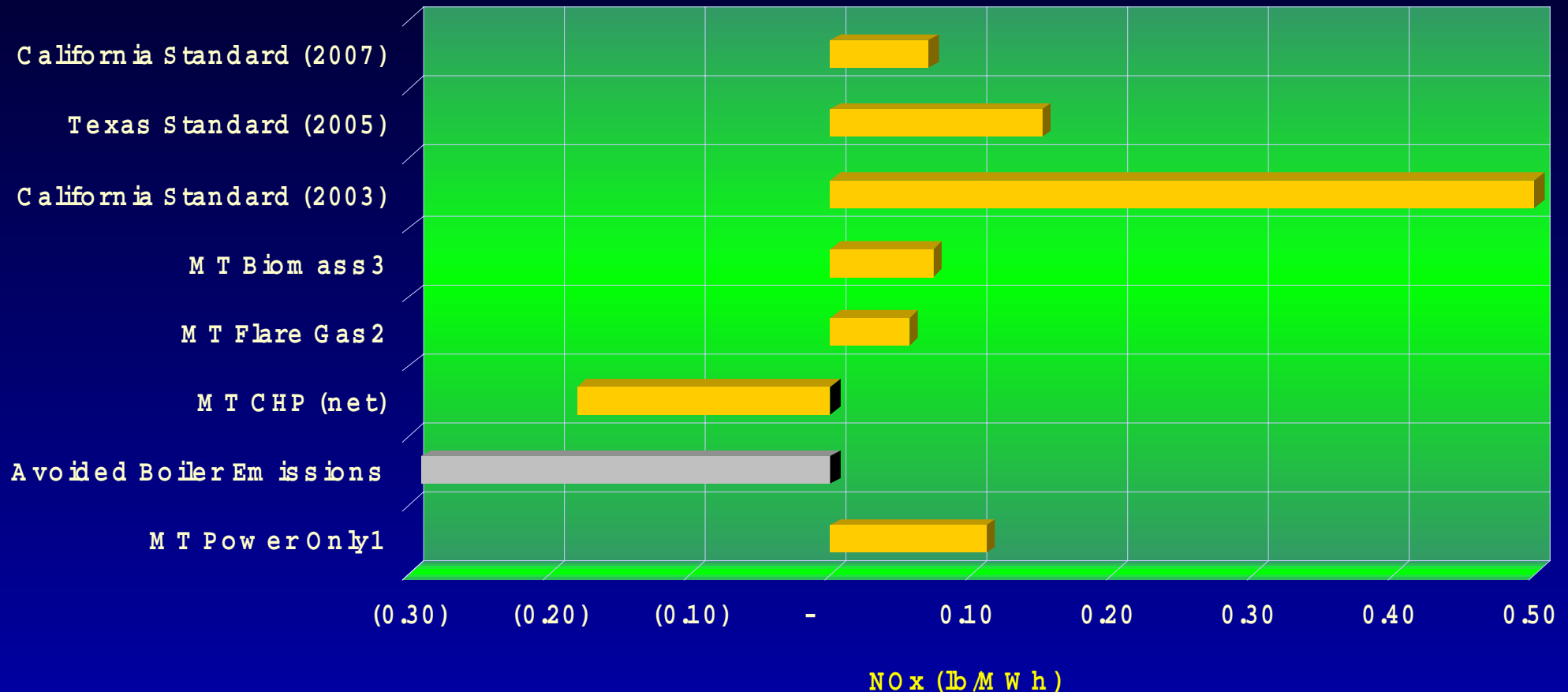


Proving Safety and Reliability



- Over 1 million operating hours
- Over 25,000 near continuous hours and 14,000 cycles on a single machine
- The only technology that is certified to the California state interconnection standard.
- Listed to UL 2200, the new generator standard
- Listed to the UL 1741 grid interconnect standard
- Capstone MicroTurbines were the first generators of ANY type state-approved by New York for DG interconnection
- Meet CE, CSA and other international standards

Providing Clean Power Today



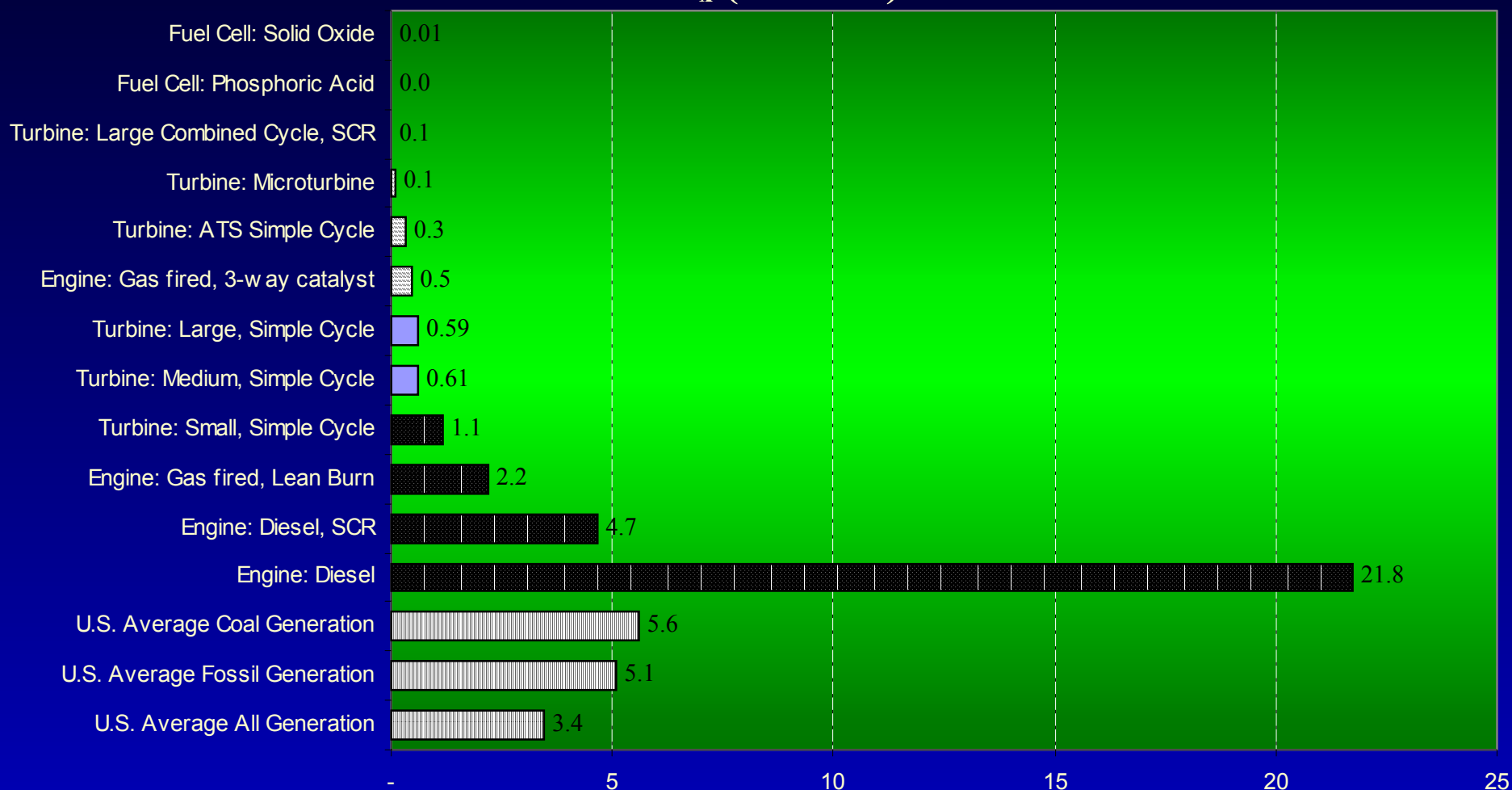
Sources:

- 1 "Select Gaseous Emissions Data from the SMUD Capstone 30 Microturbine", California Air Resources Board, September 2001.
- 2 Independent test results of Sweet and Sour Oil Batteries
- 3 "Puente Hills Land Fill Capstone Turbine Emissions Source Test", March 2000

Microturbine emissions are already near levels projected of Fuel Cells



NO_x (lb/MWh)



Source: Joel Blumstein, Energy and Environmental Analysis, Inc, Prepared for the Regulatory Assistance Program

Deployment Issues

- Utilities are the most successful Electric Service Providers and should be allowed to own DER for use in grid support and for meeting customers' energy needs
- Tariffs should be established to incentivize efficient fuel utilization through the deployment of Cooling, Heating and Power technologies to meet customer energy needs.
- Tariffs and other mechanisms should be used to encourage sustainable and renewable technologies.
- ESPs and utilities should be able to compete on their merits, not through regulatory advantage.

Other Deployment Issues

- The regulations/tariffs need to be stable.
- Standardized Interconnection
- Standby Rates and exit fees
- Distribution wheeling
- Outcome rather than technology driven policies